CLAIMS

[1] An ultrasonic diagnostic apparatus comprising a probe which transmits and receives ultrasonic waves to and from an object to be inspected, a transmission means which outputs transmission signals for driving the probe, a reception means which processes reception signals received by the probe, and an image reconstruction means which reconstructs an ultrasonic image using the reception signals outputted by the reception means, wherein

the transmission means creates and outputs the transmission signals corresponding to a composite modulation code sequence composed from two or more modulation code sequences, and the reception means is provided with a demodulator which demodulates the modulation based on the composite modulation code sequence for the reception signals.

[2] The ultrasonic diagnostic apparatus according to claim 1, wherein the transmission means generates the transmission signals by successively outputting waveforms on the basis of coefficients of code elements of the composite modulation code sequence.

[3] The ultrasonic diagnostic apparatus according to claim 1 or 2, wherein the composite modulation code sequence is a composite modulation code sequence composed from a first modulation code sequence and a second modulation code sequence,

the demodulator comprises a first demodulator for demodulating the modulation based on the first modulation code sequence, and a second demodulator for demodulating the modulation based on the second modulation code sequence, and the reception signals outputted by the probe are demodulated by one of the first and second demodulators,

and then further demodulated by the other demodulator.

[4] The ultrasonic diagnostic apparatus according to claim 3, wherein the code interval of the first modulation code sequence is larger than the code interval of the second modulation code sequence, and

the first demodulator and the second demodulator have such a configuration that the reception signals outputted from the probe should be demodulated by the first demodulator and then demodulated by the second demodulator.

[5] The ultrasonic diagnostic apparatus according to claim 3 or 4, wherein the probe comprises multiple oscillators, the reception signals are outputted from each of the multiple oscillators, the reception means comprises a phasing addition means which performs phasing of the reception signals outputted from each oscillator and adds them,

the first demodulator is disposed at a position for demodulating the reception signals before phasing addition thereof performed in the phasing addition means, and the second demodulator is disposed at a position for demodulating the reception signals after phasing addition in the phasing addition means.

[6] The ultrasonic diagnostic apparatus according to claim 3 or 4, wherein the probe comprises multiple oscillators, the reception signals are outputted from each of the multiple oscillators, the reception means comprises a phasing addition means which performs phasing of the reception signals outputted from each oscillator and adds them, and

both the first and second demodulators are disposed at a position for demodulating the reception signals after phasing addition in the phasing addition means.

[7] The ultrasonic diagnostic apparatus according to

claim 3 or 4, wherein the probe comprises multiple oscillators, the reception signals are outputted from each of the multiple oscillators, the reception means comprises a phasing addition means which performs phasing and adding of the reception signals outputted from each oscillator, and

both the first and second demodulators are disposed at a position for demodulating the reception signal before phasing addition in the phasing addition means.

[8] The ultrasonic diagnostic apparatus according to claim 3 or 4, wherein the code length of the second modulation code sequence is equivalent to or shorter than the code interval of the code elements constituting the first modulation code sequence, and coefficients of the code elements constituting the composite modulation code sequence are obtained by multiplying coefficient of each code element of the first modulation code sequence and each coefficient of the code elements constituting the second modulation code sequence.

[9] The ultrasonic diagnostic apparatus according to claim 1, wherein the transmission means comprises a code storage means in which coefficients of multiple kinds of modulation code sequences are stored beforehand, a selection means which selects two or more modulation code sequences from those stored in the code storage means, and a composing means which composes the two or more modulation code sequences with adjusting the coefficients of them to desired code intervals to generate a composite modulation code sequence.

[10] The ultrasonic diagnostic apparatus according to claim 1, wherein the transmission means comprises a composite code storage means in which multiple kinds of the composite modulation code sequences are stored beforehand,

and a selection means which selects one composite modulation code sequence from those stored in the composite code storage means.

[11] An ultrasonic diagnostic apparatus comprising a probe which transmits and receives ultrasonic waves to and from an object to be inspected, a transmission means which outputs transmission signals for driving the probe, a reception means which processes reception signals received by the probe to obtain reception signals of which harmonics are emphasized, and an image reconstruction means which reconstructs an ultrasonic harmonic image using the reception signals outputted by the reception means, wherein

the transmission means creates and outputs the transmission signals corresponding to a composite modulation code sequence composed from two or more modulation code sequences and having phase shift amounts with respect to the fundamental wave as values of code elements, and the reception means is provided with a demodulator which demodulates the modulation based on the composite modulation code sequence for the reception signals.

[12] The ultrasonic diagnostic apparatus according to claim 11, wherein the transmission means generates the transmission signals by successively outputting waveforms representing the phase shift amounts as values of the code elements of the composite modulation code sequence.

[13] The ultrasonic diagnostic apparatus according to claim 11 or 12, wherein the composite modulation code sequence is a composite modulation code sequence composed from a first modulation code sequence and a second modulation code sequence,

the reception means has a first demodulator for demodulating the modulation based on the first modulation

code sequence for the reception signals, and a second demodulator for demodulating the modulation based on the second modulation code sequence for the reception signals, and the first and second demodulators have such a configuration that the reception signals should be demodulated by one of the first and second demodulators, and then further demodulated by the other demodulator.

[14] The ultrasonic diagnostic apparatus according to claim 13, wherein the coefficients of the code elements of the first and second modulation code sequences are two values of +1 and -1, and the phase shift amounts as the values of the code elements of the composite modulation code sequence are phase shift amounts corresponding to degrees of multiplied -1 in multiplication of the first and second modulation code elements.

[15] The ultrasonic diagnostic apparatus according to claim 14, wherein phase shift amounts of the code elements of the composite modulation code sequence are determined as (180°/M) x N, wherein M is a degree of harmonic to be emphasized, and N is the degree of -1.

[16] The ultrasonic diagnostic apparatus according to any one of claims 11 to 15, wherein the reception means comprises a filter for eliminating fundamental wave components from the reception signals demodulated by the first and second demodulators.

[17] The ultrasonic diagnostic apparatus according to any one of claims 11 to 15, wherein the transmission means outputs waveform signals of the composite modulation code sequence and waveform signals of another composite modulation code sequence in which the phase shift amounts of the code elements of the composite modulation code sequence are each further shifted by a predetermined amount of phase, and

the reception means has a reception signal composing means which offsets fundamental wave components by composing reception signals of waveform signals first outputted among the transmission signals of two of the composite modulation code sequences with reception signals of waveform signals outputted afterward.

[18] The ultrasonic diagnostic apparatus according to claim 14, wherein the transmission means comprises a storage means which stores the first and second modulation code sequences, a phase difference determination means which receives the first and second modulation code sequences from the storage means to count the degree of -1 and assigns a predetermined phase shift amount depending on the degree, and a waveform storage means which stores multiple kinds of waveforms corresponding to predetermined phase shift amounts and outputs a waveform corresponding to the phase shift amount determined by the phase difference determination means as transmission signals.

[19] The ultrasonic diagnostic apparatus according to claim 13, wherein the transmission means comprises a composite code storage means which stores multiple kinds of composite modulation code sequences beforehand, and a selection means which selects one composite modulation code sequence from those stored in the composite code storage means.

[20] The ultrasonic diagnostic apparatus according to claim 13, wherein the code interval of the first modulation code sequence is larger than the code interval of the second modulation code sequence, and

the first and second demodulators are disposed so that the reception signals outputted from the probe should be demodulated by the first demodulator and then demodulated by the second demodulator.